1222 Research Park Drive
Davis
CA 95618
www.sierraenergy.com
(530) 759-9827

SIERRA ENERGY

EXTERNAL TECHNICAL MEMO

Notes on what Equipment / Design Area:	FastOx® Gasification Process Explanation for US EPA Determination Confirmation
Revision No.:	1.10
Date of Last Revision:	1-Aug-2019
Last Revised by:	D.M. Dodd, CTO Sierra Energy

This External Technical Memo (ETM) provides an overview of the Sierra Energy (SE) FastOx Gasification biorefinery and pilot demonstration equipment installed at Fort Hunter Liggett (FHL), Monterey County, to allow the US EPA to review and confirm SE's determination that the installed equipment is not subject to the Standards of Performance for Other Solid Waste Incinerators Rule, 40 CFR Part 60, Subpart EEEE.

The Purpose of Gasification

As defined by the US Department of Energy (DOE), gasification "… is a mature technology pathway that uses a controlled process involving heat, steam, and oxygen to convert [solid feed materials] to hydrogen and other products, without combustion."[1] The main goal of SE FastOx and other gasification technologies is to take a typically-unusable solid feed material and produce an intermediate highly-versatile and usable synthetic gas (syngas) that can be readily converted to sustainable (and potentially 'renewable') end-products, such as:

- Hydrogen (via catalysis and/or membrane purification);
- Liquid transportation fuels (such as diesel, jet fuel, gasoline, methanol or other alcohols via catalysis, or ethanol via biological processes);
- Renewable Natural Gas (RNG) (via catalysis or biological processes);
- Electricity (via molten-carbonate and solid-oxide fuel-cells, gas turbines or internal combustion engines)
- Chemicals (such as plastics or ammonia via catalysis)

Depending on the solid feed material source, the final end-products (produced from the intermediate gasification syngas) should be able to offset fossil-based fuels and commodities, and can have significantly lower carbon intensities. As a result, gasification will play an important role in helping any advanced economy lower its carbon intensity and meet its sustainability goals.

[1] Source: US DOE, EERE: https://www.energy.gov/eere/fuelcells/hydrogen-production-biomass-gasification

Given that FastOx gasification syngas is used to produce highly-desirable end-products, the incineration or combustion of the solid feed material is unacceptable, as it produces an exhaust stream of predominantly fully-oxidized compounds (carbon dioxide (CO_2) and water (H_2O)), that cannot be further reacted (without significant energy input or additional fuel addition) to make these desirable end-products. Therefore, the fundamental purpose of gasification is to produce a syngas with the maximum content of carbon monoxide (CO) and hydrogen (H_2). This is generally the opposite of incineration or combustor unit technologies that focus on the (attempted) complete destruction of the solid material, with or without in some instances recovery of heat and/or electricity from the large volume of hot exhaust).

There are several recent incinerator/combustor unit technological developments that are aimed to reduce the overall emissions footprint of the solid feed material destruction/incineration process, by generating less exhaust volume. Conventional 'excess air' incinerator or combustor will utilize 50-80%[2], 80-100%[3] or as high 300%[4] excess air depending on the material being incinerated and the system configuration. These newer, lower-emission footprint incinerators/combustor units include:

- Combined starved-air + secondary combustion, or
- Combined pyrolysis + secondary combustion

These above two (2) technology types were developed to reduce the total volume of exhaust generated and requiring cleaning.

While lower volumes of exhaust are generated in these newer 'staged-incinerator' technologies, in both scenarios, the end result is significant volumes of waste exhaust (mainly CO_2, H_2O, nitrogen [N_2] and trace pollutants) being cleaned (as best as possible) and emitted to atmosphere, with little, if-any, positive energy-production.

To reinforce that the FastOx gasification process is a net-producer of quality intermediate fuelgas (and not incinerator or combustor unit exhaust) that is subsequently converted onsite into sustainable (and potentially renewable) energy products/commodities, Sierra Energy has been awarded the following contracts:

- California Energy Commission (CEC), AB-118 Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) to demonstrate the production of sustainable Fisher-Tropsch (FT) diesel fuels from waste wood and post-recycling waste residuals via FastOx gasification (Contract No. ARV-11-019)
- US Department of Defense (DoD), Environmental Security Technology Certification Program (ESTCP) to demonstrate the production of sustainable electricity from waste wood and post-recycling waste residuals via FastOx gasification (Contract No. W912HQ-13-C-0075)
- US DoD Defense Logistics Agency (DLA) Small Business Innovation Research (SBIR) Phase 1 contract to research and test sustainable fuel-cell ready Hydrogen fuel production from FastOx gasification syngas. (Contract No. SP4701-15-C-0103)
- PG&E and Sempra Utilities contract to complete a feasibility study at their direction, to calculate the Levelized Cost of Renewable Natural Gas (RNG) production from waste wood and biomass feedstocks, for their potential future procurement/acquisition at California Project sites. (Contract No. 2700192606)

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[2] Source: Rensselaer Polytechnic, NY: https://www.rpi.edu/dept/chem-eng/Biotech-Environ/incinerator.html
[3] Source: US EPA https://www3.epa.gov/ttn/chief/ap42/ch02/final/c02s01.pdf
[4] Source: US EPA https://www3.epa.gov/ttn/chief/ap42/ch02/final/c02s03.pdf

The Specifics of the FastOx® Gasification Process

A FastOx Gasification system/biorefinery would include the following major unit operations as shown in the generic BFD below.

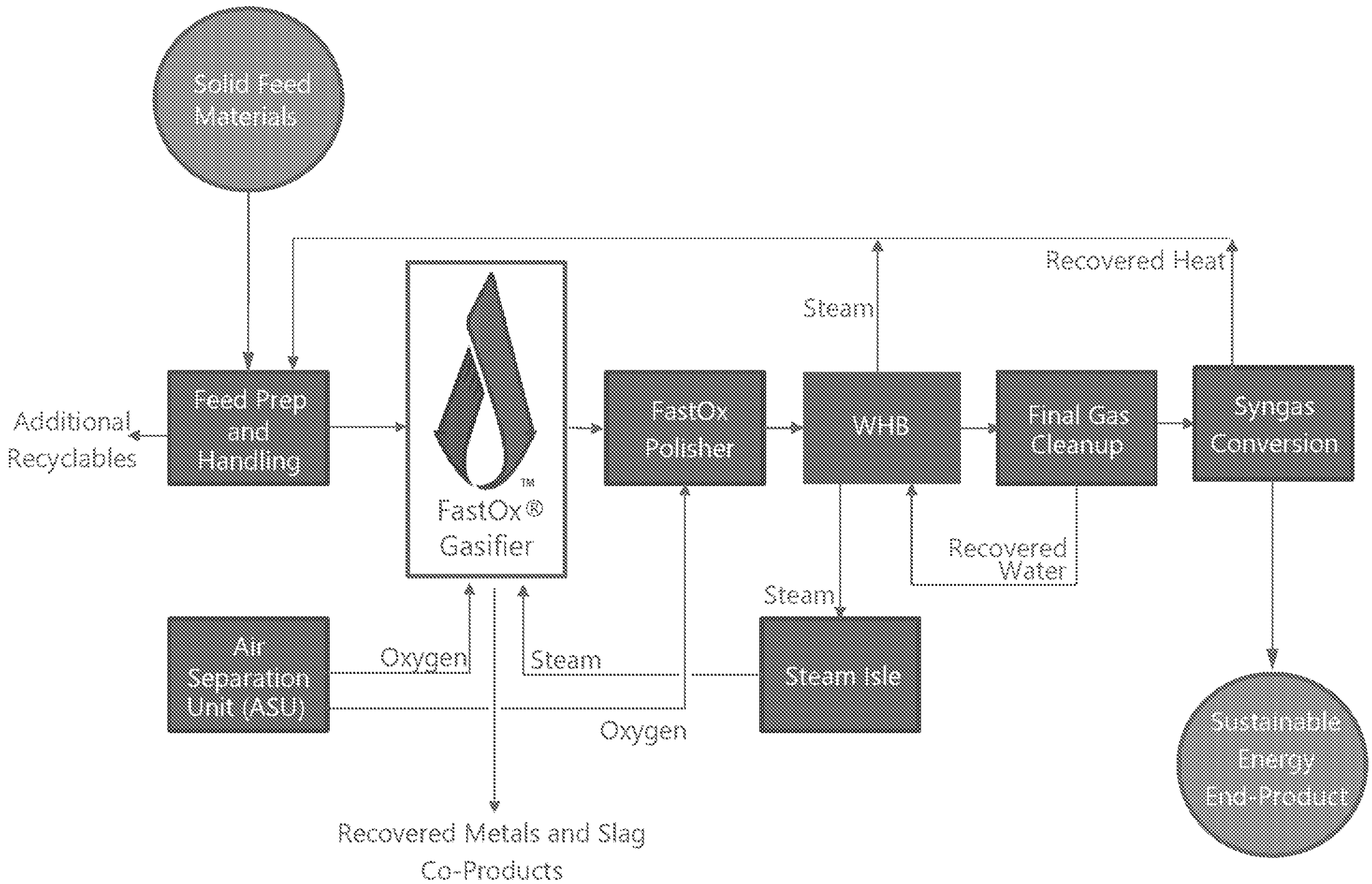

FIGURE 1: Block Flow Diagram for a typical FastOx Gasification System

The FastOx gasifier is a sealed and pressurized fixed-bed updraft gasifier, where reacting gases (oxygen and steam) are continuously injected at the base of the reactor and the solid feed material being converted to syngas is semi-continuously loaded from the top (see Figure 2). A 'fixed-bed' or 'packed-bed' of materials is maintained inside the FastOx gasifier reactor with various temperature and reaction zones occurring within that packed-bed, as detailed below.

<u>The reaction zones within the FastOx Gasifier</u>

Solid waste descends slowly through the gasifier by gravity, passing through four reaction zones (see Figure 2), including:

1. Drying Zone: occurs when hot syngas produced at the bottom of the gasifier rises and passes through the newly-added solid feed materials in the top zone of the unit, drying the solid feed as it passes. The operating temperature of this zone is between 82 °F – 302 °F.

2. Devolatilization Zone: is where most of the volatile organic matter is driven off into syngas products. The operating temperature of this zone is between 302 °F – 932 °F.

3. Partial oxidation Zone: when the residual carbon-containing materials in the waste react with the injectants of steam and oxygen, producing additional syngas. The operating temperature of this zone is approximately 3632 °F – 4000 °F

4. Melting Zone: where the inorganic compounds melt due to the high temperatures occurring in the partial oxidation zone. These inorganic compounds collect at the bottom of the unit and are continuously removed as safe, inert molten stone and alloyed metals. The operating temperature is between 2732 °F – 3272 °F.

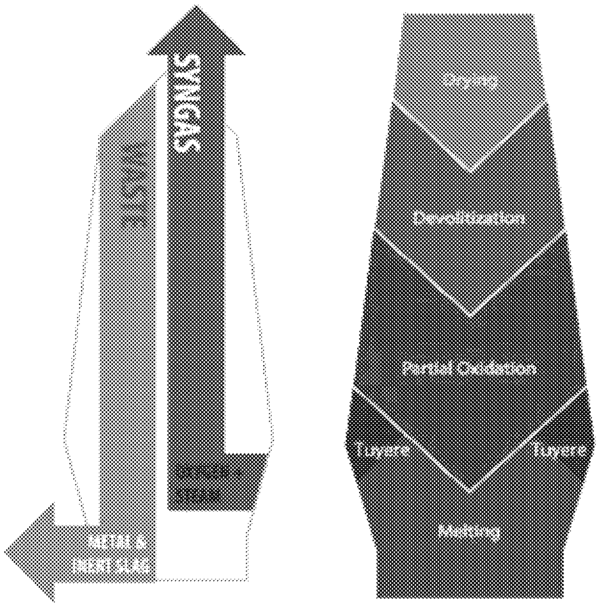

FIGURE 2: FastOx Gasifier schematics showing main inputs/outputs and reaction zones.

<u>FastOx Polisher and Recuperator Unit Operations</u>
Downstream of the FastOx Gasifier are unit operations to ensure high quality syngas production and maximized equipment reliability and uptime.

The purpose of the FastOx Polisher is to further react condensable hydrocarbons in the gas stream produced by the FastOx gasifier into additional syngas. This not only removes the possibility of the compounds condensing out in low-velocity and low-temperature zones within the system, but also increases the volume of usable, more-homogeneous syngas available for conversion to renewable end-products.

High temperature syngas from the polisher is sent to the recuperator – a system designed to cool the syngas down to a temperature that can be handled by the primary syngas cleaning systems, while subsequently recovering heat from the hot syngas (for reuse within the plant).

<u>Syngas Cleaning Unit Operations</u>
The syngas cleaning unit operations included in a FastOx biorefinery depend on the project scale, solid feed materials selected for conversion, the local air quality requirements, and the specifications provided by the syngas-to-end-product technology vendors.

To reiterate that the FastOx Gasification technologies are fundamentally different from incinerators or combustors, please see information below examples:

- Figures 3 and 4 show FastOx syngas composition that proves the production of a highly-versatile, intermediate natural-gas replacement (that is subsequently converted into final sustainable (and potentially renewable) end-products)
    - again, incinerators and combustors would produce large volumes of exhaust (CO2, H2O, N2 and trace pollutants), not a useable fuel gas
- Table 1 and Figure 5 show the FastOx recovered inert stone (slag) test results, that proves the production of a versatile, safe, non-leaching co-product from the high-temperature FastOx gasification process
    - Again, incinerators and combustors would produce appreciable amounts (typically 15-20%wt.) of bottom ash and fly ash, both of which can be difficult to dispose of given the typically-hazardous nature of these by-products.

Air Toxics LTD.
Laboratory Services Since 1989

Client Sample ID: FASTOX 2011-03-10 (WP)
Lab ID#: 1103233-02A
NATURAL GAS ANALYSIS BY MODIFIED ASTM D-1945

File Name:	9031112	Date of Collection: 3/10/11 3:15:00 AM
Dil. Factor:	1.00	Date of Analysis: 3/11/11 12:37 PM

Compound	Rpt. Limit (%)	Amount (%)
Oxygen	0.10	0.34
Nitrogen	0.10	1.1
Carbon Monoxide	0.080	54
Methane	0.00010	2.7
Carbon Dioxide	0.010	6.6
Ethane	0.0010	0.11
Ethene	0.0010	0.049
Acetylene	0.0010	Not Detected
Propane	0.0010	0.020
Isobutane	0.0010	Not Detected
Butane	0.0010	0.0034
Neopentane	0.0010	Not Detected
Isopentane	0.0010	Not Detected
Pentane	0.0010	0.0011
C6+	0.010	0.044
Hydrogen	0.080	31

Figure 3: Example empirical FastOx Syngas data from operations on waste biomass

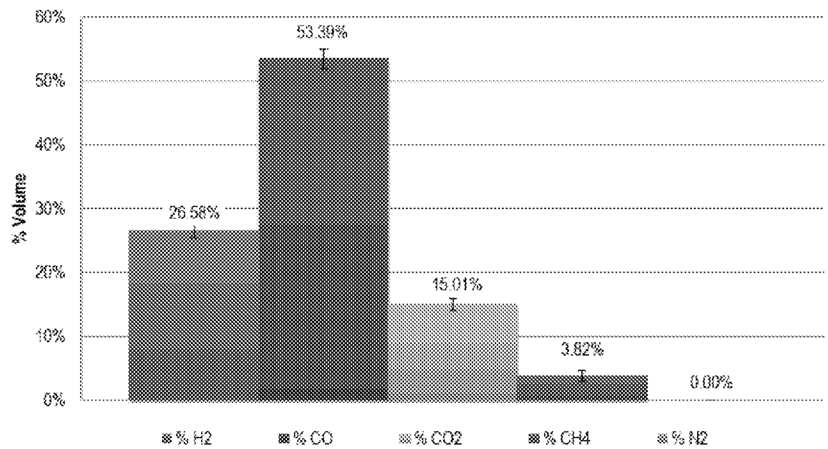

Figure 4: Example empirical FastOx bulk Syngas composition from operations on municipal solid waste

Table 1: FastOx gasification inert stone co-product testing results, proving safe, non-hazardous classification

	TTLC					STLC			TCLP		
Elements (Symbol)	Regulatory Limit Limit	Result	Haz. Waste?	STLC Test req?	TCLP Test req?	Limit	Result	Haz. Waste?	Limit	Result	Haz. Waste?
	mg/Kg	mg/Kg	Yes / No	Yes / No	Yes / No	mg/L	mg/L	Yes / No	mg/L	mg/L	Yes / No
Antimony (Sb)	500	ND	No	No	--	15	ND	No	--	ND	No
Arsenic (As)	500	0.76	No	No	No	5	ND	No	5	ND	No
Barium (Ba)	10,000	960	No	No	No	100	5	No	100	0.59	No
Beryllium (Be)	75	0.86	No	No	--	0.75	ND	No	--	ND	No
Cadmium (Cd)	100	ND	No	No	No	1	ND	No	1	ND	No
Chromium (Cr)	2,500	160	No	Yes	Yes	5	1.1	No	5	ND	No
Cobalt (Co)	8,000	3	No	No	--	80	0.068	No	--	ND	No
Copper (Cu)	2,500	280	No	Yes	--	25	0.054	No	--	0.046	No
Lead (Pb)	1,000	ND	No	No	No	5	0.2	No	5	0.054	No
Mercury (Hg)	20	ND	No	No	No	0.2	ND	No	0.2	ND	No
Molybdenum (Mo)	3,500	11	No	No	--	350	0.15	No	--	ND	No
Nickel (Ni)	2,000	54	No	No	--	20	1.3	No	--	0.096	No
Selenium (Se)	100	0.71	No	No	No	1	ND	No	1	ND	No
Silver (Ag)	500	0.48	No	No	No	5	ND	No	5	ND	No
Thallium (Tl)	700	0.99	No	No	--	7	ND	No	--	ND	No
Vanadium (V)	2,400	12	No	No	--	24	0.081	No	--	ND	No
Zinc (Zn)	5,000	2	No	No	--	250	ND	No	--	ND	No

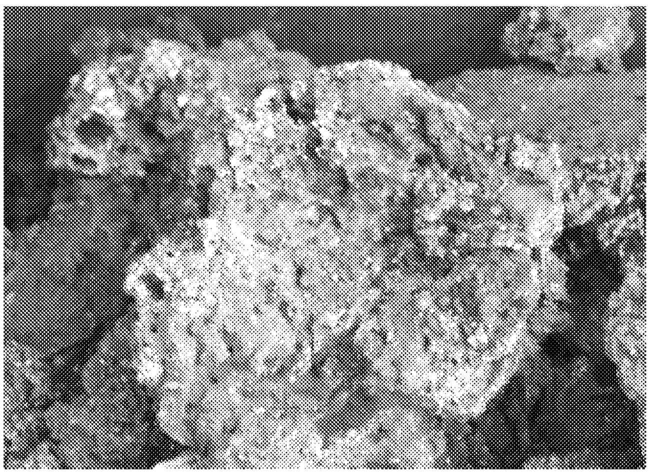

Figure 5: FastOx gasification inert stone co-product example

Description of the FastOx Gasification System installed at Fort Hunter Liggett

Project Location:	US Army Garrison Fort Hunter Liggett (FHL) Bldg 339, Infantry Road, Jolon, CA 93928 (180,000-acre facility in Southern Monterey county, used for primarily for exercise/training various branches of the US military)
Coordinates:	35°59'22.2"N, 121°13'52.1"W

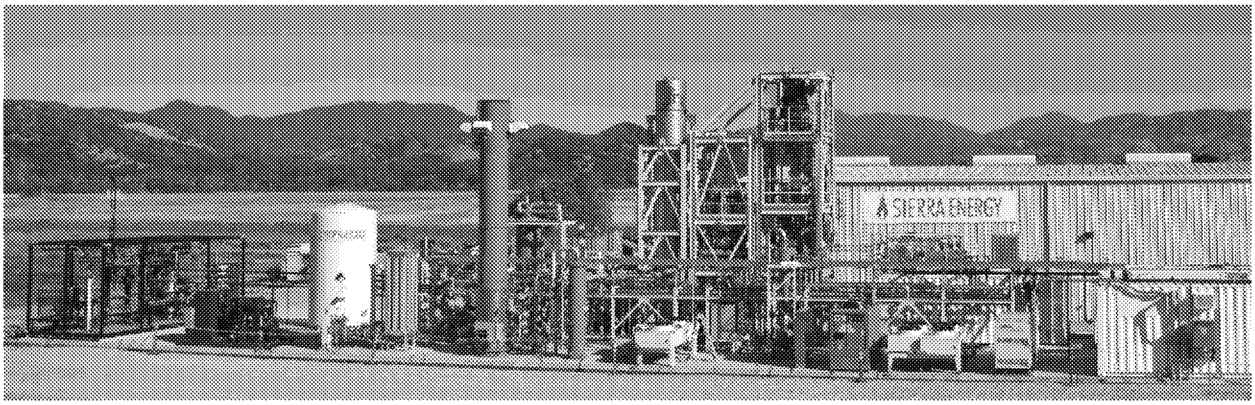

Figure 6: FastOx Gasification Biorefinery installed at FHL

The FastOx gasification pilot demonstration system installed at FHL was developed to meet the requirements of the California Energy Commission (CEC) and Environmental Security Technology Certification Program (ESTCP) contracts (both awarded in 2012), to demonstrate the production of sustainable Fischer-Tropsch (FT) Diesel fuel and sustainable electricity from waste wood and post-recycling MSW residuals.

Initial Engineering was started in 2013. Permitting began 2014 and was fundamentally completed (to allow the construction of the system) in 2016.

Table 2: Summary of the FHL Permits Required and Acquired

Topic	Agency	Requirement	Date Obtained
Air permit – Authority to Construct (ATC)	Monterey Bay Unified Air Pollution Control District, now known as Monterey Bay Air Resources District (MBARD)	Permit to Procure and install equipment per the Air Board's requirement	5-Feb-2015 and updated 9-Jun-2017 and 1-Feb-2018 and 5-Dec-2018
Air Permit – Permit to Operate	MBARD	Permit to operate the system / plant continuously	In progress
Solid Waste Permit Exemption	Monterey County Department of Health	Ensure system / plant meets all state and local requirements	1-Mar-2016
Water	FHL Dept. of Public Works (DPW)	Ensure backflow preventers meet all state and local requirements	12-Jul-2017
Wastewater (Discharge to FHL)	Central Coast Regional Water Quality Control Board (CCRWQCB)	Confirmation that system does not require FHL to obtain new permit	8-Apr-2015

Topic	Agency	Requirement	Date Obtained
CEQA / NEPA	CEC (Responsible agencies include CCRWQCB, MBARD and FHL DPW)	Project needs to be CEQA compliant given the funding sources requirement. NEPA FONSI was completed and considered a Negative Declaration substitute, this was reviewed and determined by the CEC to be CEQA Compliant.	1-Jun-2015
Cal/OSHA	Cal/OSHA	Confirmation that the system does not trigger PSM (Process Safety Management)	24-Jan-2018
SPCC	FHL DPW	Double-wall tanks and concrete tertiary spill containment areas	Coordinated with FHL DPW
Pressure Vessels	Cal/OSHA Pressure Vessel Division and FHL DPW	Meets CA Dept. of Industrial Relations requirements	7-Jun-2016 to 9-Mar-2017
Boiler	Cal/OSHA Pressure Vessel Division	Permit to operate steam boiler	29-Jun-2017
Fire	FHL Fire Department	Inspections to confirm equipment, and layout meets FHL FD, California and Federal requirements	4-Apr-2017
Structural	FHL DPW	Meets CA requirements	27-Apr-2016 to 24-Feb-2017

Overview of the FastOx Gasification Process at FHL

In Figure 7 below is a block flow diagram of the FHL system and major stream flows.

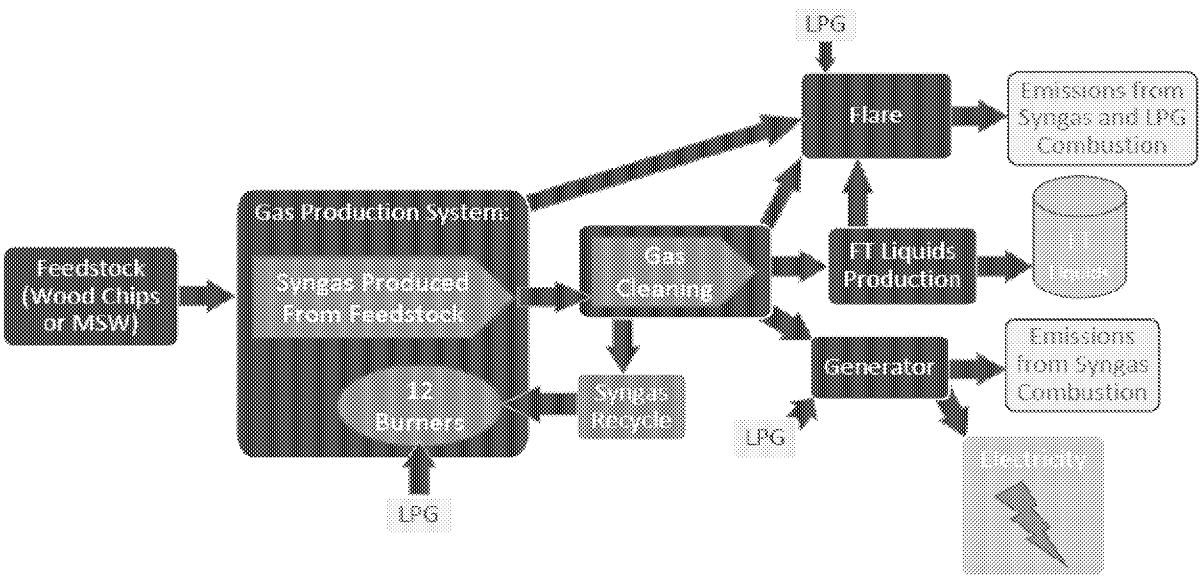

Figure 7: Schematic of the FHL FastOx Gasification to Sustainable End-Products System

Waste Materials at FHL

The FHL system is fully permitted (other than final MBARD Permits to Operate (PTO) which are being pursued currently) to accept wood waste and MSW.

- The wood waste is a combination of biomass (tree limbs, stumps, etc.) and waste wood (miscellaneous clean lumber) that has been inspected by FHL Department of Public Works (DPW) to remove any unacceptable (treated or painted) materials. Both material classifications are generated 'on post' within the boundaries/fence line of FHL and brought to the FastOx gasification facility by FHL's DPW.
- At FHL there is a robust recycling program, that includes a multi-bin system for the separation of recyclables from the as-generated MSW. As a result, the materials brought to the FastOx Gasification biorefinery are post-recycling MSW residuals. Per SE's permit requirements, the operators still conduct a thorough examination of this received material for the identification and removal of any unacceptable materials (recyclable materials (that are sent over to FHL's existing Recycling Program for their purposes), hazardous materials, materials that could damage the equipment etc.).

All material types undergo inspection and then size-reduction via slow-speed grinding into a 1-2" size fraction.

The FastOx Gasification, Polishing and Recuperation unit operations are described in the generic FastOx Process Description section starting on page 3 of this document. There are oxy-fuel burners (that can utilize LPG or clean FastOx syngas) which are used to pre-heat the refractory-lined FastOx gasifier and polisher process vessels during start-up, and can also be used during normal operations to add process heat and alter process chemistry to maximize/maintain syngas production and sustainable end-product yields.

Figure 8: FastOx Gasification Biorefinery at FHL. Bulk syngas cleaning modules shown lower-right

Syngas Cleaning Unit Operations at FHL

Syngas from the recuperator then enters the syngas cleaning isle which has five (5) main components

- Venturi scrubber

    - The venturi scrubber subsystem receives a low-temperature (<212°F) syngas and washes the syngas with the primary purpose of residual particulate matter removal.

      The scrubber fluid pH and conductivity are closely monitored. To maintain the pH of the scrubbing fluid, a pH control loop and metering pump is used to add sodium hydroxide solution to the system as necessary. A conductivity loop automatically drains scrubber water from the vessel and adds fresh water when required.

- Packed bed scrubber
    - This subsystem receives the post-venturi scrubber syngas and further removes acidic compounds and moisture (excess water) from the syngas utilizing a chilled solution over a packed bed.

      A heat exchanger is included in the recirculating scrubber solution stream to remove the heat that is absorbed by the scrubbing fluids from the incoming syngas and the heat of reaction. Constant temperature is maintained by varying the chilled water flow to the heat exchanger. The scrubber fluid pH and conductivity are closely monitored. To maintain the pH of the scrubbing fluid, a pH control loop and metering pump is used to add NaOH solution to the system as necessary. A conductivity loop automatically drains scrubber water from the vessel and adds fresh water when required.

- H2S guard bed
    - Due to the presence of sulfurous compounds in waste streams, hydrogen sulfide (H2S) is a highly undesirable component of the syngas produced by the gasifier. If not removed, it can corrode lines and equipment, become SOx emissions from the electrical genset, and poison/deactivate catalysts for FT Diesel production. The H2S Guard Bed removes this compound using an adsorption process.

      A bed of Iron Oxide housed within the vessel has a high affinity for H2S. As the syngas passes over this porous material, the H2S attaches onto adsorbent sites on the FeO bed and is thus removed from the syngas stream.

- Syngas blower
    - Before it reaches the syngas header, the syngas from the gasifier needs to pass through several pieces of equipment with associated pressure drops.. A rotary lobe type gas blower is used to boost the pressure of the syngas coming from the H2S Guard Bed. A pressure control loop varies the motor speed of the blower in order to maintain a steady 3 PSIG at the syngas header.

- Carbon bed
    - This subsystem provides a final guard to remove any organic compounds that have not already been converted and/or removed.

<u>Syngas Conversion to Sustainable Energy End-Products at FHL</u>
Finally, the syngas enters the low-pressure syngas header from where it is sent to the syngas-to-end product conversion equipment (catalytic FT diesel fuel equipment provided by Research Triangle Inc. (RTI[5]) and/or Siemens-Guascor[6] genset to produce sustainable electricity) or to be recycled back to the FastOx unit operations. Any excess syngas (not utilized/converted to sustainable end-products is oxidized in an enclosed flare rated for 10 MMBTU/hr).

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[5] https://www.rti.org/practice-area/syngas-processing
[6] https://new.siemens.com/global/en/products/energy/power-generation/gas-engines/sl-engines.html

Photographs of the syngas-to-FT Diesel equipment (that complete the waste-to-sustainable fuels biorefinery process cycle installed at FHL), part-funded by the California Energy Commission and DoD are shown below.

Figure 9: RTI Syngas Conditioning Module (upstream of FT Isle)

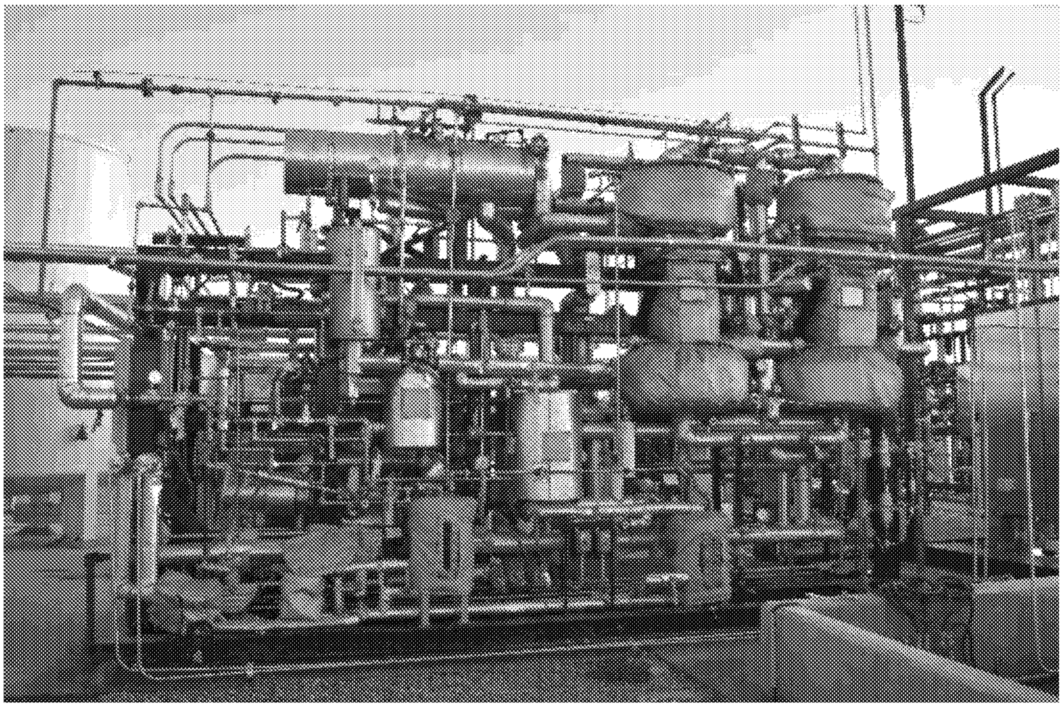

Figure 10: RTI FT Isle for the demonstration and production of ~42gal/day of FT fuels

40 CFR Part 60 Subpart EEEE Definitions and Evaluation of Applicability to the FHL System

§60.2977 Other solid waste incineration (OSWI) unit means either a very small *municipal waste combustion unit* or an *institutional waste incineration unit*, as defined in this subpart. Unit types listed in § 60.2887 as being excluded from the subpart are not OSWI units subject to this subpart. While not all OSWI units will include all of the following components, an OSWI unit includes, but is not limited to, the municipal or institutional solid waste feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The OSWI unit does not include air pollution control equipment or the stack. The OSWI unit boundary starts at the municipal or institutional waste hopper (if applicable) and extends through two areas:
(1) The combustion unit flue gas system, which ends immediately after the last combustion chamber or after the waste heat recovery equipment, if any; and
(2) The combustion unit bottom ash system, which ends at the truck loading station or similar equipment that transfers the ash to final disposal. The OSWI unit includes all ash handling systems connected to the bottom ash handling system.

Overall Evaluation	**While the FHL Biorefinery will be accepting "MSW" and "Institutional Waste" and is ultimately located on an "Institutional Facility" accepting <35 ton/day of solid waste materials, the MSW, Institutional Waste, Wood Waste and other solid waste materials are not being combusted/incinerated (converted to predominantly exhaust and ash with a corresponding volume reduction) and instead is being converted to a clean syngas that is then converted to sustainable energy end-products (FT Diesel and Electricity).**
Overall Determination	**FastOx Gasification is not combusting/incinerating MSW, IW, Wood Waste and other Solid Wastes (instead converting it to sustainable energy end-products), and therefore not deemed an Other Solid Waste Incineration (OWSI) Unit.**

- *§60.2977 Very small municipal waste combustion unit* means any *municipal waste combustion unit* that has the capacity to combust less than 35 tons per day of municipal solid waste or refuse-derived fuel, as determined by the *calculations in § 60.2975.*
  - *§60.2977 Municipal waste combustion unit* means, for the purpose of this subpart and subpart FFFF of this part, any setting or equipment that combusts *municipal solid waste* (as defined in this subpart) including, but not limited to, field-erected, modular, cyclonic burn barrel, and custom built incineration units (with or without energy recovery) operating with starved or excess air, boilers, furnaces, pyrolysis/combustion units, and air curtain incinerators (except those air curtain incinerators listed in § 60.2888(b)).

Evaluation	While SE will be accepting "MSW", the MSW is not being combusted (converted to predominantly exhaust and ash with a corresponding volume reduction) and instead is being converted to a syngas that is then converted to sustainable energy end-products (FT Diesel and Electricity). The regulation language also defines 'pyrolysis/combustion' as a technology covered by this definition, but as explained earlier in this document, pyrolysis/combustion is in-effect a 2-stage process to combust/render to ash solid feed materials, just with lower emissions volumes compared with conventional excess-air combustion. To clarify, FastOx gasification – for the production of an intermediate syngas and subsequently sustainable energy end-products – is fundamentally, and in practice, a completely different process.

Determination	**FastOx Gasification is <u>not</u> combusting MSW (instead converting it to sustainable energy end-products), and therefore <u>not</u> deemed a Municipal Solid Waste Combustion Unit.**

- *<u>§60.2977 Municipal solid waste</u>* means refuse (and refuse-derived fuel) collected from the general public and from residential, commercial, institutional, and industrial sources consisting of paper, wood, yard wastes, food wastes, plastics, leather, rubber, and other combustible materials and non-combustible materials such as metal, glass and rock, provided that: (1) the term does not include industrial process wastes or medical wastes that are segregated from such other wastes; and (2) an incineration unit shall not be considered to be combusting municipal solid waste for purposes of this subpart if it combusts a fuel feed stream, 30 percent or less of the weight of which is comprised, in aggregate, of municipal solid waste, as determined by§ 60.2887(b).

Evaluation	The FHL project will accept and convert (to sustainable end-products) a solid feed stream with 100%wt. MSW as defined by section §60.2977. Note, a significant portion of the MSW consumed will be clean "wood" (as listed above as a constituent of "MSW") from the FHL facility.
Determination	**The FHL project will indeed be using 'MSW'.**

- *<u>§60.2977 Calculations in §60.2975</u>* (b) Capacity of a very small municipal waste combustion unit. For very small municipal waste combustion units that can operate continuously for 24-hour periods, calculate the unit capacity based on 24 hours of operation at the maximum charge rate. To determine the maximum charge rate, use one of two methods:

  (1) For very small municipal waste combustion units with a design based on heat input capacity, calculate the maximum charging rate based on the maximum heat input capacity and one of two heating values:

  (i) If your very small municipal waste combustion unit combusts refuse derived fuel, use a heating value of 12,800 kilojoules per kilogram (5,500 British thermal units per pound).

  (ii) If your very small municipal waste combustion unit combusts municipal solid waste, use a heating value of 10,500 kilojoules per kilogram (4,500 British thermal units per pound).

  (2) For very small municipal waste combustion units with a design not based on heat input capacity, use the maximum design charging rate.

Evaluation	The FastOx Gasification process at FHL is designed for 10 metric tonnes per 24hrs (22,050 lb/day) of solid feed acceptance and conversion to syngas and subsequent sustainable energy end-products.
Determination	**The FHL project will indeed be using a process that is rated for <35 tons per day of MSW acceptance**

- *<u>§60.2977 Institutional waste incineration unit</u>* means any combustion unit that combusts *<u>institutional waste</u>* (as defined in this subpart) and is a distinct operating unit of the institutional facility that generated the waste. Institutional waste incineration units include field-erected, modular, cyclonic burn barrel, and custom built incineration units operating with starved or excess air, and any air curtain incinerator that is a distinct operating unit of the institutional facility that generated the institutional waste (except those air curtain incinerators listed in§ 60.2888(b)).

Evaluation	While SE will be accepting "Institutional Waste", the IW is not being combusted/incinerated (converted to predominantly exhaust and ash with a corresponding volume reduction) and instead is being converted to a syngas that is then converted to sustainable energy end-products (FT Diesel and Electricity).
Determination	**FastOx Gasification is <u>not</u> combusting/incinerating Institutional Waste (instead converting it to sustainable energy end-products), and therefore <u>not</u> deemed an Institutional Waste Incineration Unit.**

- <u>*§60.2977 Institutional waste*</u> means <u>*solid waste*</u> (as defined in this subpart) that is combusted at any <u>*institutional facility*</u> using controlled flame combustion in an enclosed, distinct operating unit: whose design does not provide for <u>*energy recovery*</u> (as defined in this subpart); operated without energy recovery (as defined in this subpart); or operated with only <u>*waste heat recovery*</u> (as defined in this subpart). Institutional waste also means solid waste (as defined in this subpart) combusted onsite in an air curtain incinerator that is a distinct operating unit of any institutional facility.
  - <u>*Solid waste*</u> means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1342), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (42 U.S.C. 2014).

Evaluation	The FastOx Gasification process at FHL will be accepting solid waste materials (primarily "garbage" and "refuse" from the list defined above) for conversion to sustainable energy end-products (FT Diesel and Electricity).
Determination	**SE will indeed be using 'solid waste' materials**

  - <u>*§60.2977 Institutional facility*</u> means a land based facility owned and/or operated by an organization having a governmental, educational, civic, or religious purpose such as a school, hospital, prison, military installation, church, or other similar establishment or facility.

Evaluation	The FastOx Gasification process at FHL is part-funded and part-owned by the US DoD ESTPC and US Army. The land, building and the majority of the equipment are owned by the US DoD, while a minority amount of the equipment is owned by SE. SE employees are onsite to commission and operate the equipment for the foreseeable future however.
Determination	**The DoD owns the majority of the FastOx Gasification equipment installed at FHL, and therefore this project site can be considered an 'Institutional Facility'.**

- *§60.2977 Energy recovery* means the process of recovering thermal energy from combustion for useful purposes such as steam generation or process heating.

Evaluation	While there would be significant heat integration within future FastOx Gasification systems (as shown in Figure 1 of a Generic FastOx biorefinery), this heat integration would not be utilizing heat from the combustion of solid feed materials, and instead would be recovering sensible heat within certain flow streams within a system (i.e. recovering heat from the hot syngas, and sending that heat over to the waste dryers to pre-dry the waste). Again, this would be typical heat recovery and reutilization to increase plant efficiency, and isn't recovering thermal energy from waste combustion.
Determination	**While there is Heat Recovery equipment included within the FHL system, this is recovering heat from hot syngas for improved thermal efficiency, not exhaust from waste combustion.**

- *§60.2977 Waste heat recovery* means the process of recovering heat from the combustion flue gases outside of the combustion firebox by convective heat transfer only.

Evaluation	While there would be significant heat integration within future FastOx Gasification systems (as shown in Figure 1 of a Generic FastOx biorefinery), this heat integration would not be utilizing heat from the combustion of solid feed materials, and instead would be recovering sensible heat within certain flow streams within a system (i.e. recovering heat from the hot syngas, and sending that heat over to the waste dryers to pre-dry the waste). Again, this would be typical heat recovery and reutilization to increase plant efficiency, and isn't recovering thermal energy from waste combustion.
Determination	**There is no Waste Heat Recovery equipment included within the FHL system, and if there were, there would still not be any combustion of solid waste materials, so there would not be solid waste combustion flue gases to recover heat from.**

Conclusions

As described above, the SE FastOx process is solely intended to gasify solid wastes under carefully controlled conditions to prevent combustion, so that a usable syngas product can be produced for use directly as a fuel gas stream or further reacted to make a liquid diesel fuel or other sustainable (and potentially renewable) energy products. Therefore, it does not meet the applicability criteria under 40 CFR Part 60, Subpart EEEE for Other Solid Waste Incinerators.